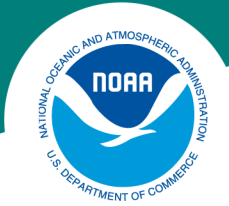


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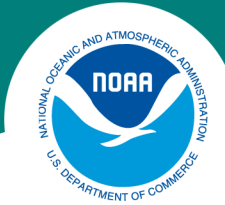
# **Lemon shark: an update on biology, fisheries and status**

**John K. Carlson**

*Southeast Fisheries Science Center*

*Panama City, FL USA*





Only one age and growth assessment  
on lemon sharks in the western North  
Atlantic (1979-1986)

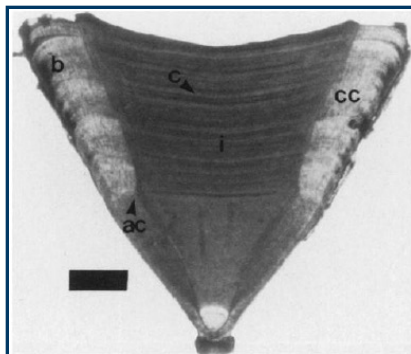
Brown and Gruber (1988)

Von Bertalanffy model:

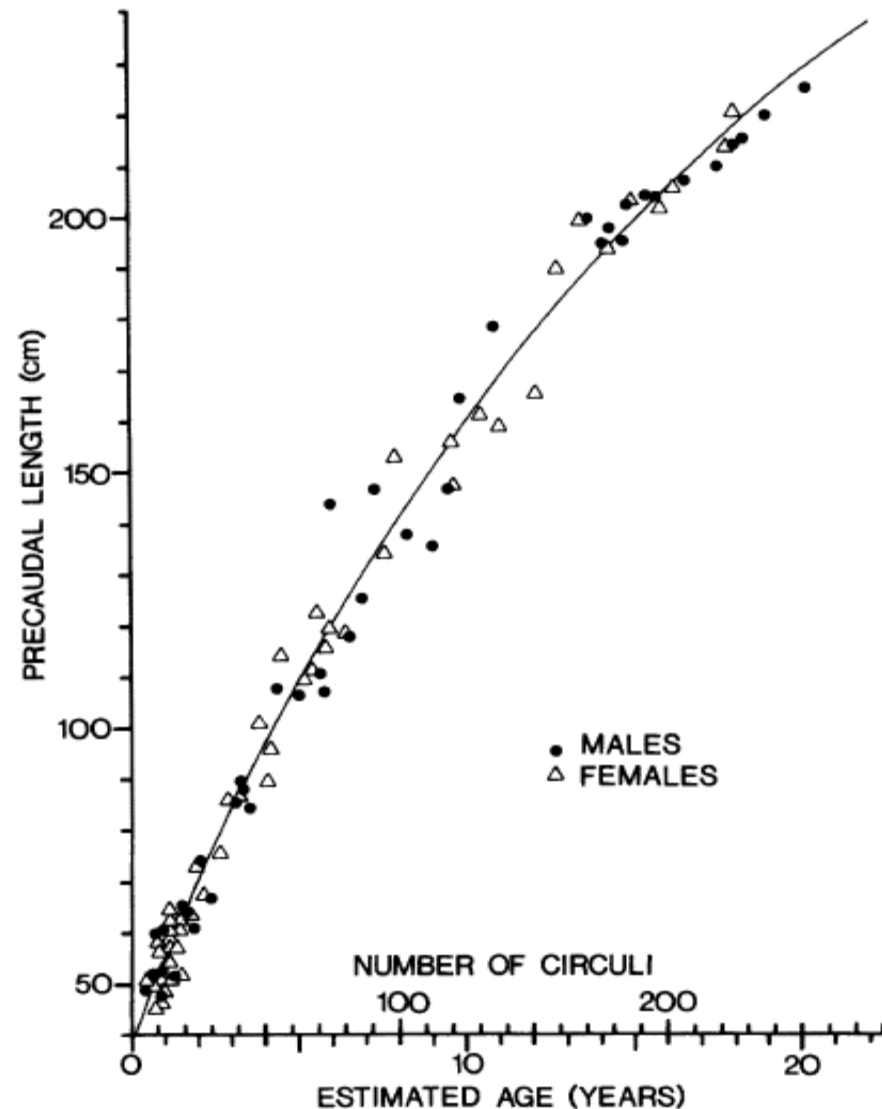
Estimated max: 317.7 cm PCL

Growth coefficient (k): 0.06

Theoretical age at zero length: -2.30 yr



## Biology





## Do lemon sharks really grow this slowly?

- Growth rates of tropical/subtropical species
  - Sandbar (*Carcharinus plumbeus*)
    - $k = 0.12$  (Pacific Ocean)
  - Silky (*Carcharinus falciformis*)
    - $k = 0.14$
  - Spinner shark (*Carcharhinus brevipinna*)
    - $k = 0.14$
- Frietas et al (2006)
  - Growth rate of juvenile lemon shark recaptures
    - $k = 0.16$

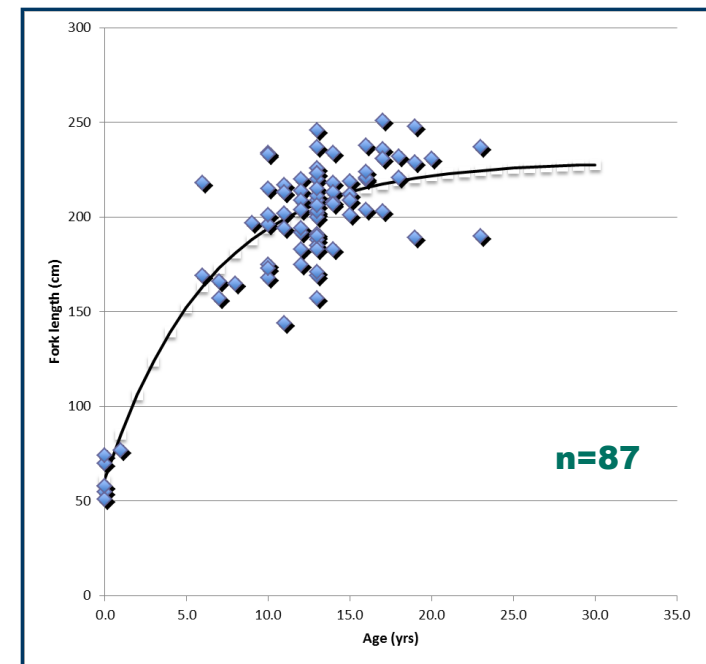
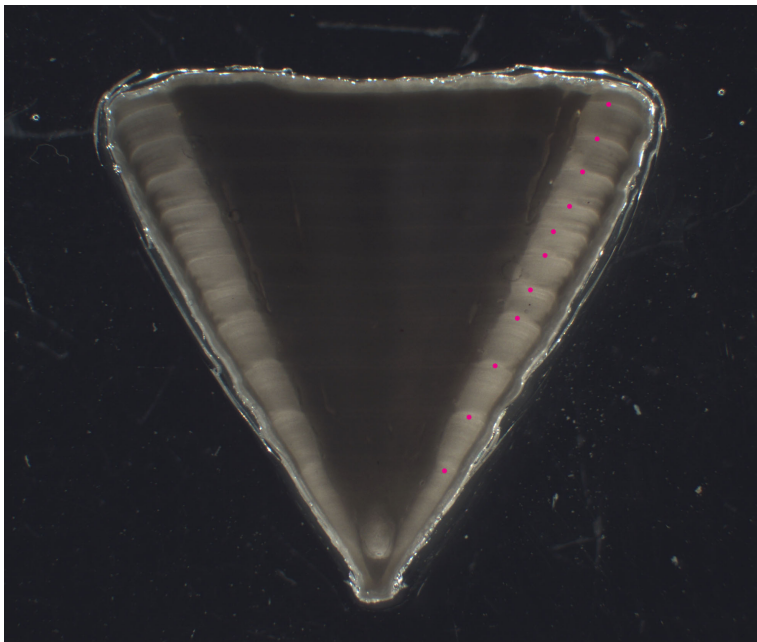
Age and growth information is often utilized for determination of natural mortality and longevity and, ultimately for calculation of vital rates in demographic models

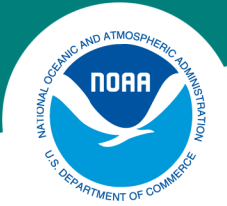
Successful fisheries management requires precise and accurate age information



## Preliminary age and growth estimates

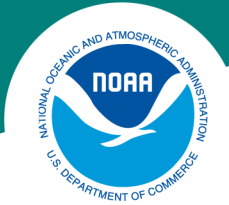
- In collaboration with Florida State University and Bimini Biological Field Station





## Preliminary life history estimates

- $L_{\infty}=229.9$  cm FL,  $k=0.16$ ,  $t_0= -1.98$  yr
  - Maximum size
    - 248 cm FL (NMFS unpublished)
    - 242 cm FL (T. Guttridge/D. Grubbs pers. com)
  - Growth coefficient similar to other tropical/subtropical carcharhinids



## Maturity and Fecundity

- No formal analysis to estimate size/age of maturity or maternity schedules
- Size/Age of maturity
  - 192-204 cm FL female (M. Bond, D. Grubbs, T. Guttridge pers. comm.)
  - Ave. mature female=216 cm FL (NMFS unpublished)
    - Back transforming length to age
      - Age of maturity 9-15 years
        - » (12– 16 years; Brown and Gruber 1988)
- Fecundity
  - 2-18 pups (Feldheim et al. 2002)
  - 7-14 pups (NMFS, unpublished)

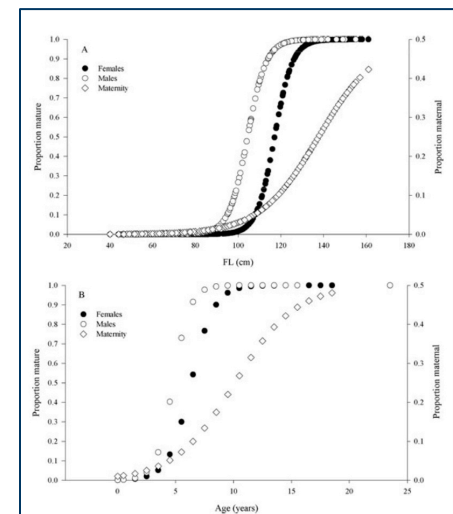
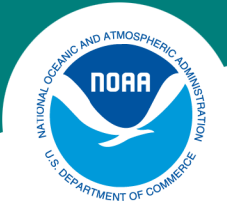


FIGURE 11. Maturity and maternity ogives for (A) FL and (B) age of male and female Blacktip Sharks in the Gulf of Mexico from combined data sets (1996–2002 and 2006–2011). Maternity ogives were multiplied by 0.5 to account for the biennial reproductive cycle and only contain data from 2006 to 2011.



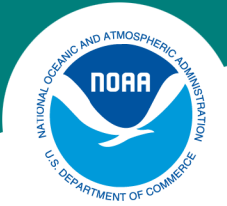
## Productivity

- Demography
  - Original life history estimates used in demographic models
    - $r_{\text{intrinsic}} = 0.03\text{-}0.06/\text{year}$  (Gedamke et al. 2007)
    - $r = 0.06/\text{year}$  (0.04-0.08) (Cortés 2002)
  - New information could suggest lemon sharks are more productive than previously determined



## **Commercial shark bottom longline fishery**



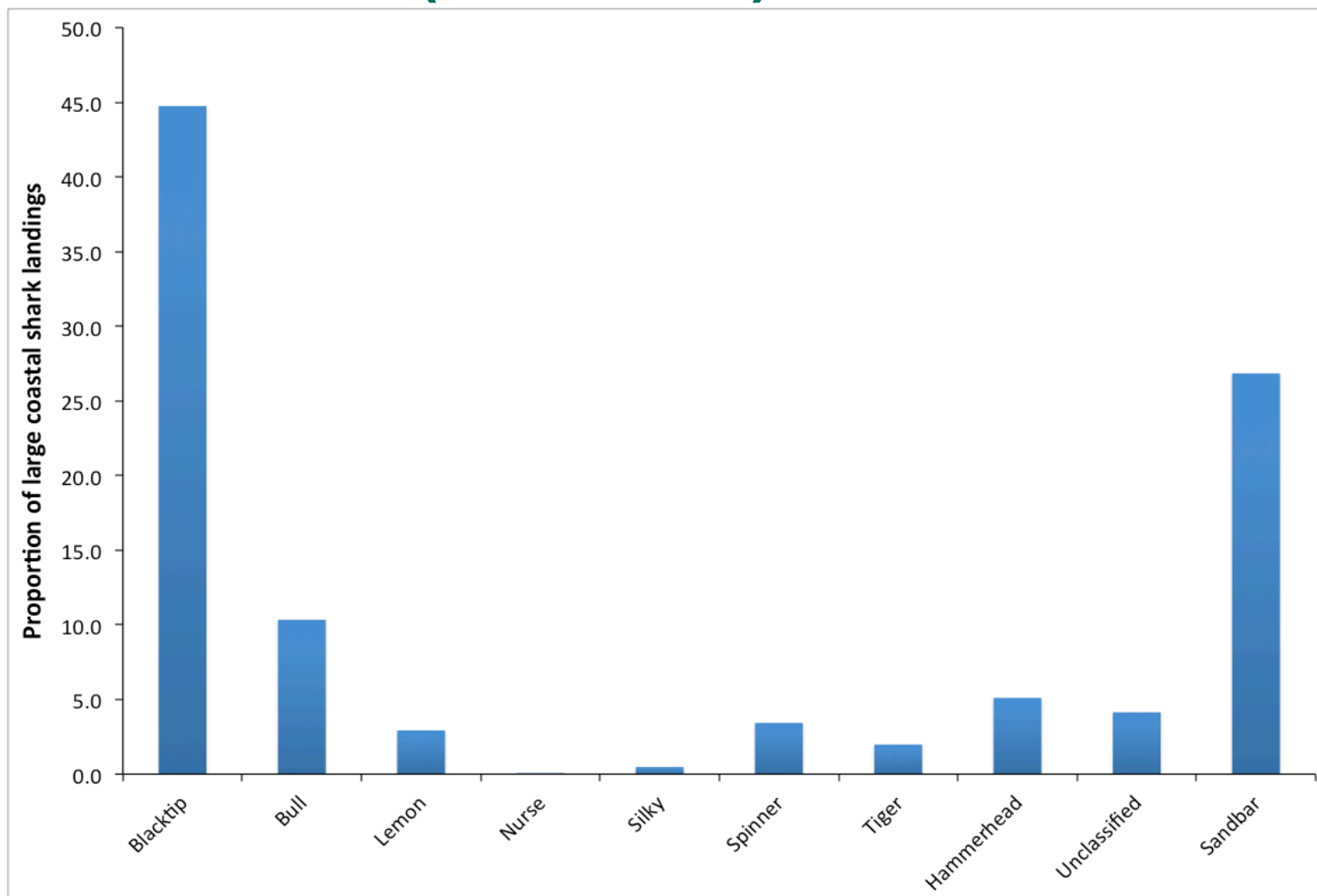


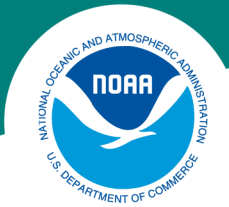
## **Shark Bottom Longline Fishery**

- Active from North Carolina through eastern Gulf of Mexico
- Gear set at sunset and soak overnight
- Haulback in the morning
- Generally fish 8-24 km of longline with 500-1500 hooks
- Trips average 1-3 days
- ~207 vessels with active directed shark fishing permits
- Target large coastal sharks but small coastal sharks, pelagic sharks, and dogfish species are also caught
- May also target reef fishes such as grouper, snapper, and tilefish

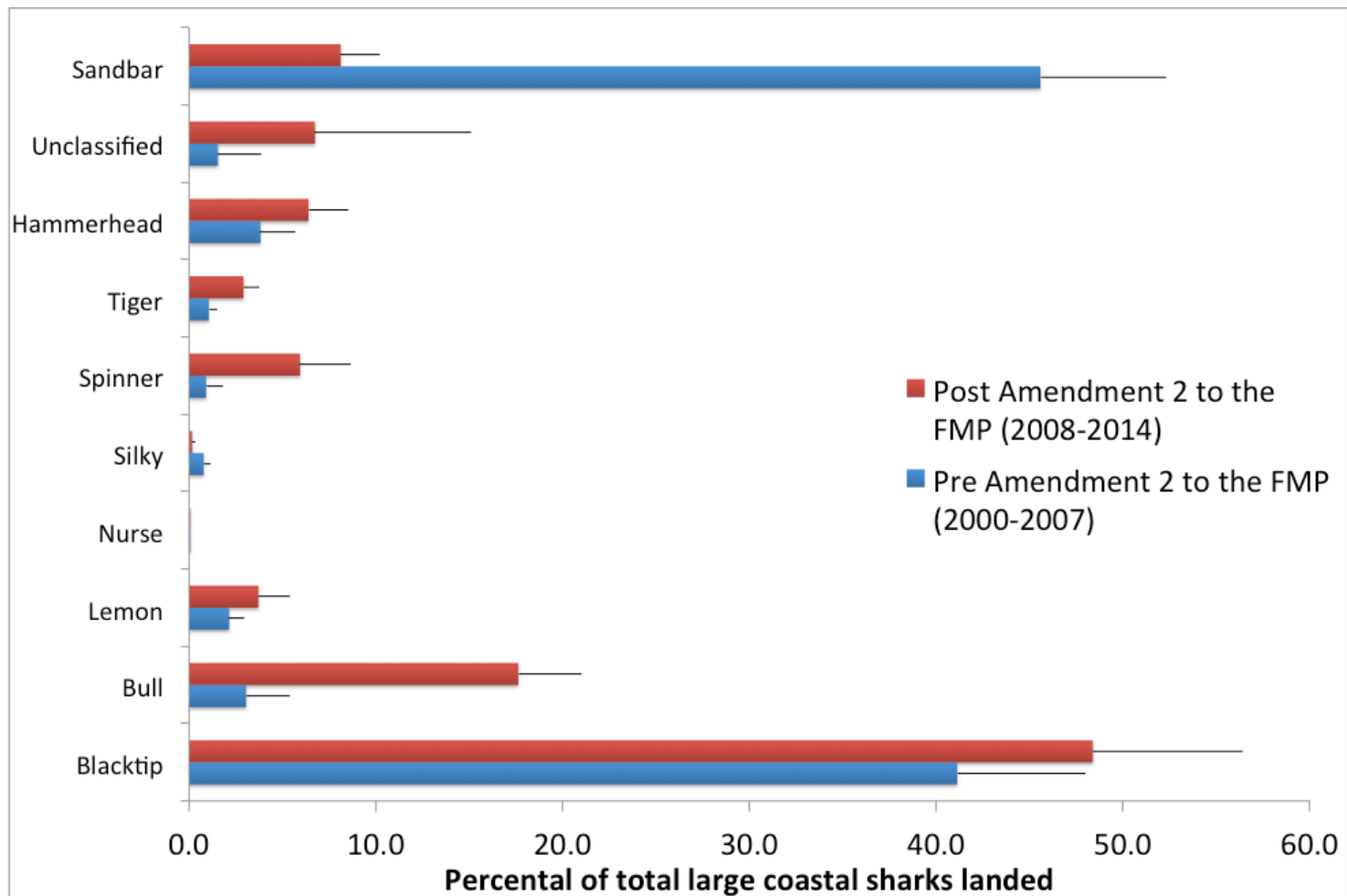


## **Shark bottom longline fishery large coastal shark landings (2000-2014)**





Lemon shark landings have not significantly changed since 2000 or Amendment 2 (~2-3%)



# Shark Bottom Longline Fishery Observer Program



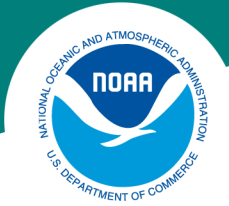
# Overview

- Program began in 1994 by Florida Museum of Natural History
  - Transferred to NMFS-Panama City Laboratory in 2005
- Sampling design
  - Stratified Random Design (2002 mandatory) (NMFS 2005)
  - Strata: Trimester season based on fishing season
  - Strata: 3 Geographic Areas
  - Observer Days Allocated in Proportion to Effort
  - Vessels Randomly Selected Independently from Each Area / Season Combination Based on Fishing Activity from Previous Year
  - 4-7% Coverage Level
- Shark Research Fishery (2008) – 8-10 vessels, 100% coverage, sandbar shark target – shut-down when quota met
  - Research Fishery also functions to conduct gear modification experiments to reduce bycatch with aid of industry

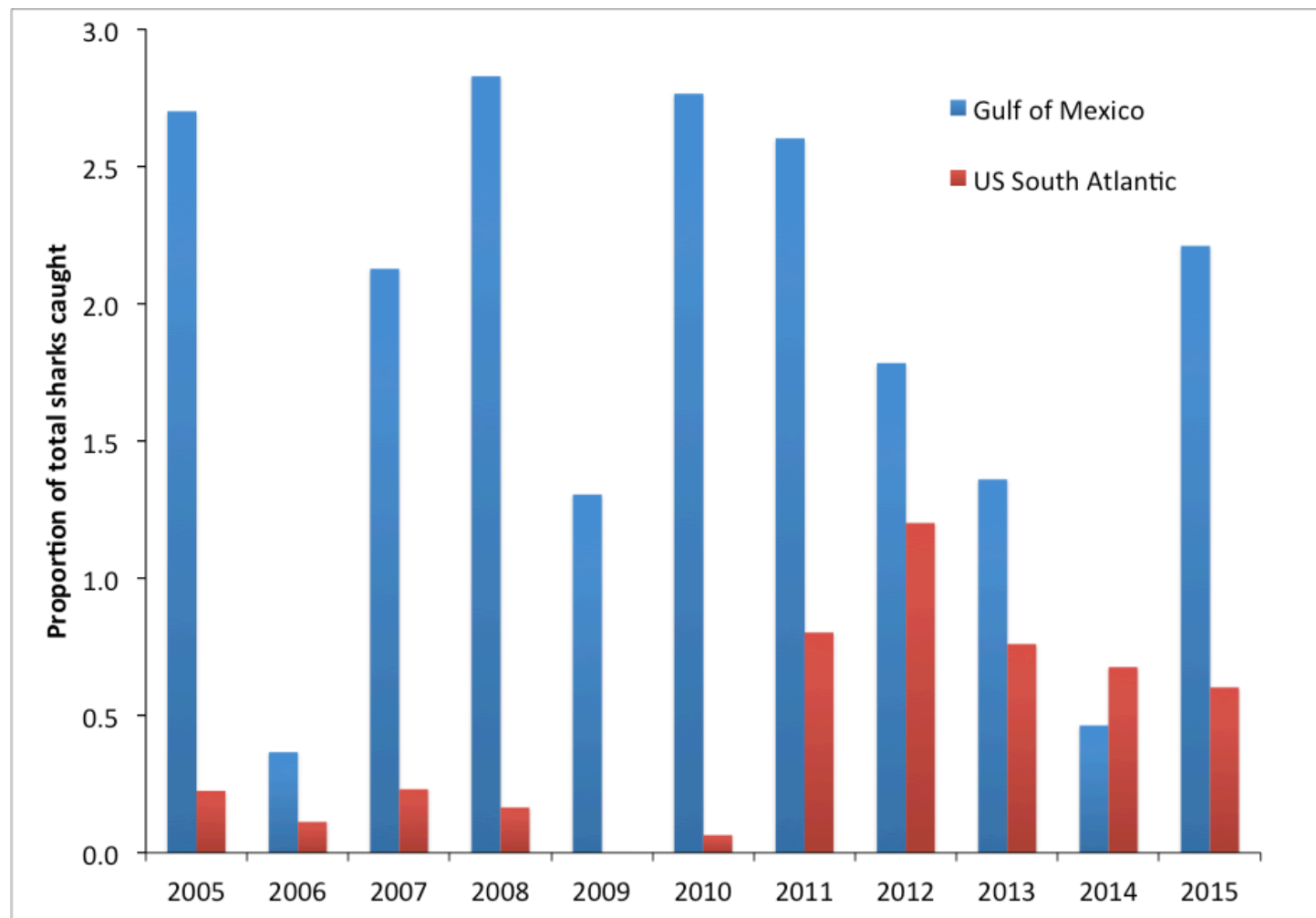
# What Data Collected

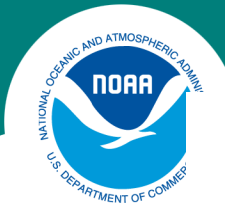
- Target: Large and Coastal Sharks
  - Mixed trips of reef fish and sharks
- Gear Information (Longline Length, Number and Kind of Hooks, Bait)
- Set Information (Location, Time of Day, Hours of Set)
- Species Captured (Kept, Discarded, Status)
  - Information collected on all species
- Biological Data (Species, Length, Life History)
  - Samples to develop age-length keys used in stock assessments



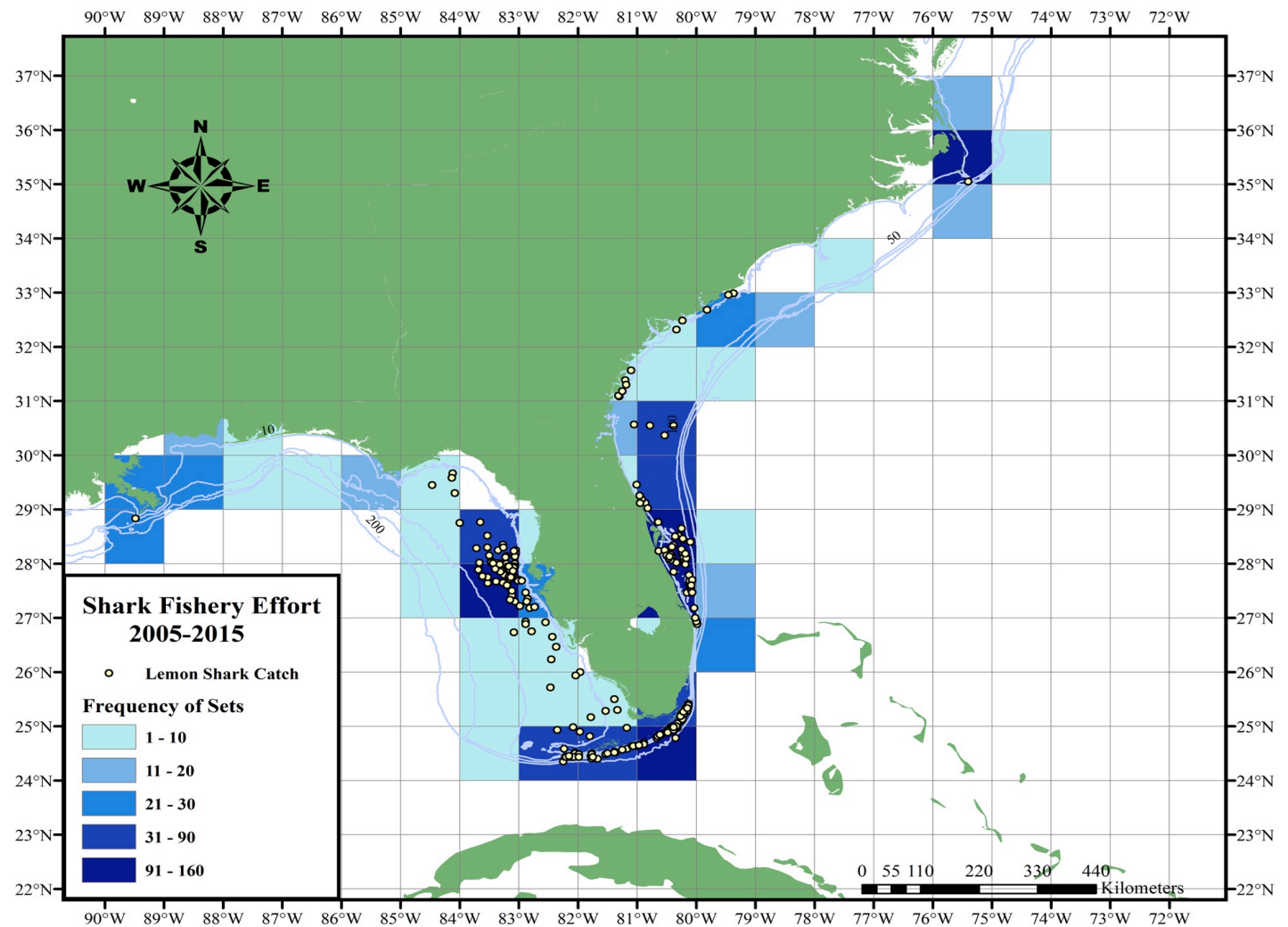


## Lemon shark catches based on observer data





## Locations of lemon shark captures

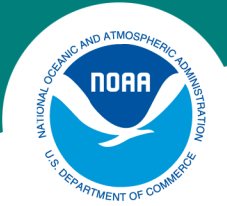


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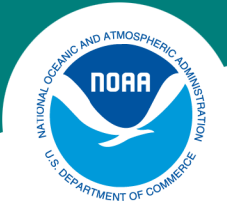
# Lemon shark disposition based on observer data -proportion of the total

	Kept	Alive	Dead	Escaped
<b>2005</b>	94.2	0.0	1.9	3.8
GOM	93.8	0.0	2.1	4.2
SA	100.0	0.0	0.0	0.0
<b>2006</b>	100.0	0.0	0.0	0.0
GOM	100.0	0.0	0.0	0.0
SA	100.0	0.0	0.0	0.0
<b>2007</b>	85.4	0.0	4.9	9.8
GOM	83.3	0.0	5.6	11.1
SA	100.0	0.0	0.0	0.0
<b>2008</b>	97.1	1.5	0.0	1.5
GOM	98.5	0.0	0.0	1.5
SA	66.7	33.3	0.0	0.0
<b>2009</b>	88.5	4.9	0.0	6.6
GOM	88.5	4.9	0.0	6.6
SA				
<b>2010</b>	88.1	5.0	0.0	6.9
GOM	89.8	3.1	0.0	7.1
SA	33.3	66.7	0.0	0.0
<b>2011</b>	93.0	7.0	0.0	0.0
GOM	98.8	1.2	0.0	0.0
SA	78.8	21.2	0.0	0.0
<b>2012</b>	90.0	4.3	0.0	5.7
GOM	87.9	0.0	0.0	12.1
SA	91.9	8.1	0.0	0.0
<b>2013</b>	97.7	0.0	0.0	2.3
GOM	96.6	0.0	0.0	3.4
SA	100.0	0.0	0.0	0.0
<b>2014</b>	89.4	0.0	0.0	10.6
GOM	83.3	0.0	0.0	16.7
SA	90.2	0.0	0.0	9.8
<b>2015</b>	95.8	1.4	0.0	2.8
GOM	95.8	0.0	0.0	4.2
SA	95.8	4.2	0.0	0.0



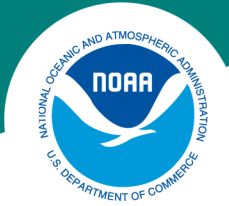
## **Shark Bottom Longline Fishery**

- Lemon sharks make up a very small percentage of large coastal shark catch
- Most catches (proportion of total shark catch) are in the Gulf of Mexico
- No change in proportion of lemon sharks caught since Amendment 2
  - No evidence of increased targeting after sandbar shark quota restriction



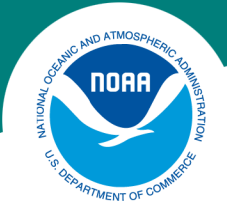
## **Status**

- IUCN red list assessment (2005: Near Threatened)
- No stock assessment available
  - Ultimately, stock assessments that utilize multiple sources of data (catch, life history and abundance trends) are the most robust analyses
  - When data are not available, abundance trends can provide a general picture of the species status, provided the data sources utilized are appropriate



## **Data sources examined for abundance information**

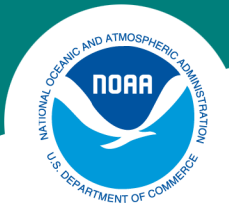
- Fishery dependent
  - Shark bottom longline observer program
- Fishery independent (scientific survey)
  - FSU Longline survey
  - RSMAS drumline survey
  - SC DNR drumline survey
  - Coastspan Longline surveys
  - NMFS SEFSC Bottom longline survey
- Many surveys report very few lemon shark captures
  - e.g. NMFS Bottom longline survey
    - fewer than 10 since 1995
- Missing data



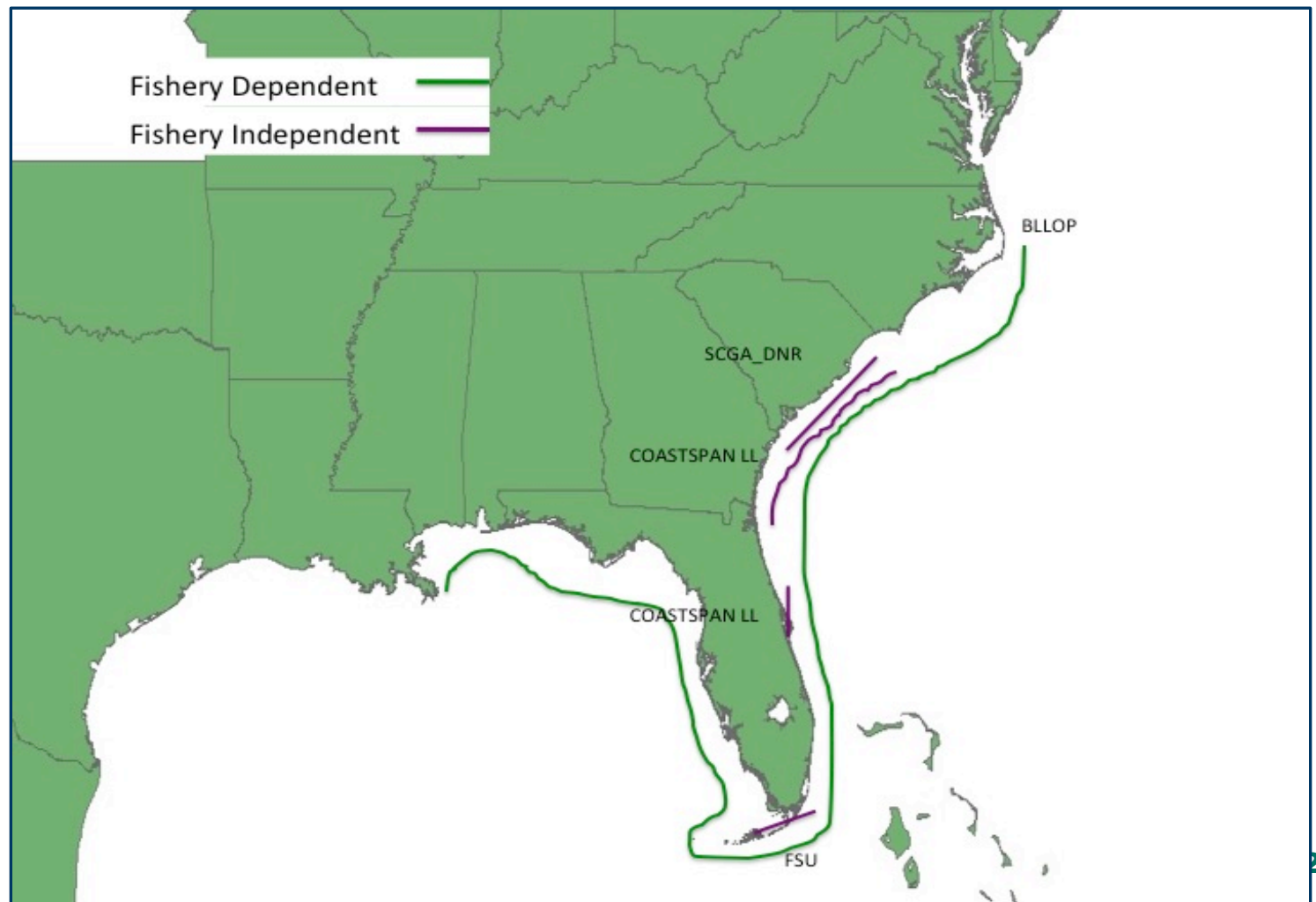
## Abundance

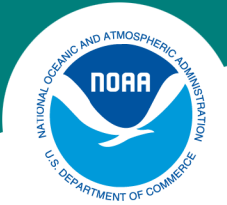
- Where possible, data standardized using Delta method
  - Design to correct for factors unrelated to abundance



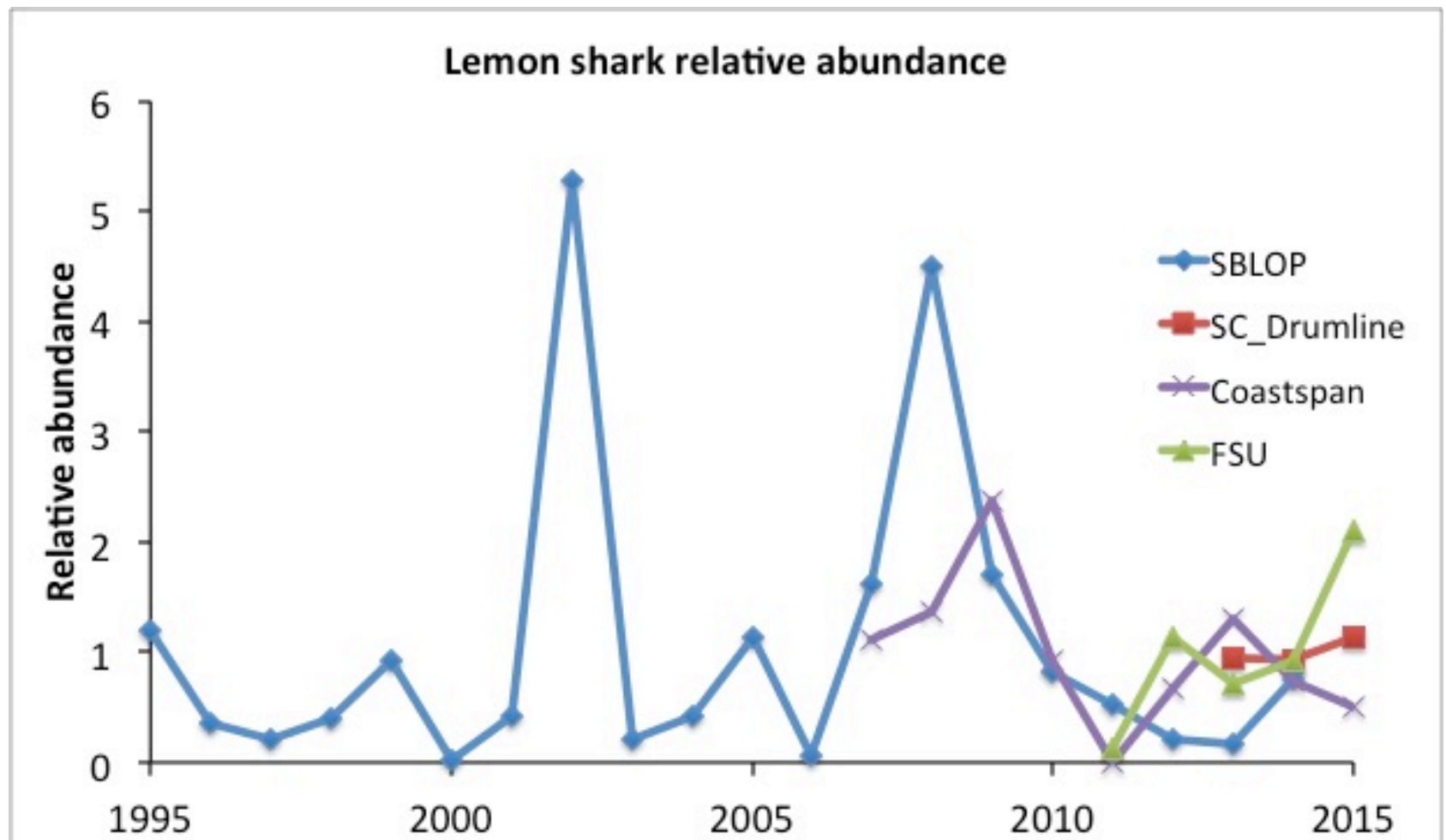


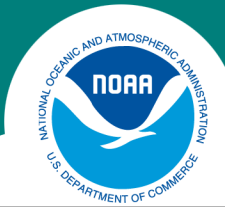
## Distribution of surveys



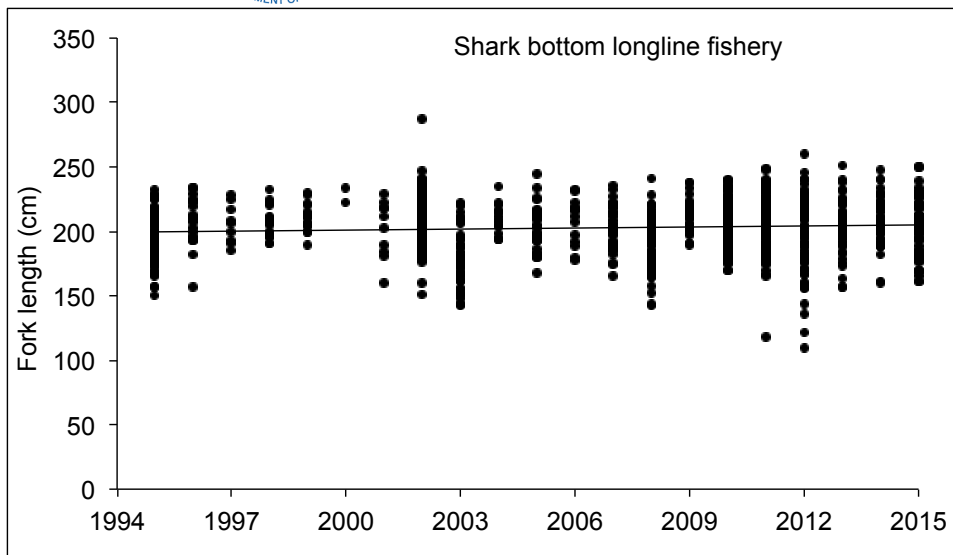


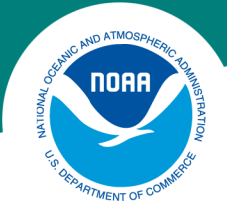
## Relative abundance





## Changes in the size composition of the population





## Conclusions

- Lemon shark may be more productive than previously assumed
- The shark bottom longline fishery is not having a significant impact on lemon sharks
- While no stock assessment is available, data on relative abundance suggests population is stable
  - No evidence of growth overfishing

